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WORK-SHARING: AN EFFICIENCY-WAGE ANALYSIS

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Abstract

This paper evaluates two approaches to work-sharing by examining both within the same macro model. The standard approach involves imposing a quantity constraint on labour market participants (a maximum number of standard hours for each worker). This approach is compared to a revenue-neutral employment subsidy financed by a tax on overtime hours – an initiative intended to harness market incentives. The paper shows that the second approach brings much preferred results – it involves lower unemployment, higher investment, and no reduction in the wage earnings of those already employed. The analysis suggests that policymakers should not reject work-sharing just because they are (justifiably) skeptical of mandated reductions in hours. The model involves the following features: (i) it is optimization-based (so there is a well-defined reason for labour market failure); (ii) it facilitates the investigation of trade-offs (so it can be determined whether improvements in unemployment must be accompanied by reductions in productivity, investment, average hours or wage rates); (iii) it involves a small open economy (so concerns about the limits to independent policy in this setting are respected); and (iv) it can be readily calibrated (so empirically relevant *quantitative* results are derived).

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1. Introduction

In policy circles, work-sharing is a topical issue – both as an initiative that might lower unemployment, and as a measure that could help societies with aging populations.[1] The European Commission has made a solid commitment to reducing standard work hours, and several European countries have already passed the corresponding legislation. While the issue is being debated in North America, no thorough-going action has yet been taken. For example, in Canada, a government Task Force (1994) has made the suggestion that the cap on the country's payroll taxes be eliminated. Since firms make no additional payment to the government for any worker who has already generated the maximum payroll tax burden, the system stimulates the use of overtime hours – not job sharing.[2] Related suggestions have appeared in the United States; for example that the payroll tax be removed on the first $10,000 of wages earned each year (Epstein, 1999, p.6).

This paper is motivated by the different approaches to this broad issue that are being pursued in Europe and North America. The European initiative has been to impose a quantity constraint on labour market participants – a maximum number of standard hours per week for each worker. To ensure political support from existing workers,

[1] There are, obviously, other reasons for reducing the length of working time – for example, an increase in the demand for leisure. Surveys conducted in European countries consistently show that the majority of workers would like to work a different number of hours than they actually work. For example, in a survey of about 30,000 individuals conducted on behalf of the European Foundation for the Improvement of Living and Working Conditions , Bielenski (2000) found that 6 percent would like to work more hours, 34 percent the same number of hours , and 60 percent would like to work fewer hours. In contrast, surveys show that in Canada and the United States, amongst those which would like to change their hours, the overwhelming majority would like to work more hours (see Khan and Lang (1995)).

[2] The Task Force Report is discussed in Donner and Lazar (1999); a related monograph is Gunderson and Reid (forthcoming). Other Canadian initiatives include HRDC's Work Sharing Program – funded by Employment Insurance – which allows EI payments for workers who take reduced work time to avoid temporary layoffs, and the 32 Hours–Action for Full Employment Group (part of the Canadian Centre for Policy Alternatives) at www.webnet/32hours/.

legislation often includes the stipulation that each individual's total wage earnings not drop as the policy is implemented. The combination of these initiatives can limit profits, and concern has been raised that work-sharing may, therefore, have detrimental effects on investment in physical capital and productivity in the longer term. The North American approach involves a reluctance to impose quantity constraints. Instead, as just noted, interest is being expressed in using taxes and subsidies to better harness, not override, market incentives. This approach has a chance of meeting Freeman's (1998, p. 217) concern that "the efforts … to create jobs through mandated cuts in hours have been, at best, marginally successful. … workers' limited willingness to accept income reductions that accompany hours reductions … inhibit work-sharing."[3]

The purpose of this paper is to evaluate these two approaches to work-sharing by examining both within one specific macroeconomic model. We have selected a macro model that can accommodate several concerns that have featured prominently in discussion at the policy level. First, work-sharing is intended to reduce *involuntary* unemployment, so any useful model must involve a well-identified source of labour-market failure. We have chosen an efficiency-wage model that relies on asymmetric information and moral hazard to justify the interpretation that unemployment is involuntary. Second, there has been concern that several important things – productivity, the incentive to invest in capital equipment, and the wages of those already employed – may be reduced by work-sharing. Since efficiency-wage analysis highlights the endogenous reaction of worker effort and productivity, and since we have extended the standard analysis to consider the demand for capital, our analysis addresses these

[3] More recently, Hunt (1999) has provided evidence based on data from the German Socio-Economic Panel which corroborates Freeman’s concern.

concerns directly. Third, there is growing concern that the scope for any policy initiative undertaken by an individual country is more limited in the new global economy. To ensure that some attention is paid to this consideration, our macro model involves a small open economy.

The final prerequisite for model selection is that it be readily calibrated, so that illustrative and empirically relevant *quantitative* results can be derived. We have chosen Summers' (1988) model of efficiency wages for this reason. Romer (1996) has drawn attention to this model as a particularly compact version of efficiency wage theory, and we have extended it to allow for a distinction between employees and hours, a variable capital stock, and several taxes and subsidies. It is worth mentioning that both the Summers model and our extension of it have two properties which are consistent with economic history. The first relates to the vast increase in productivity over the last two centuries, associated with no long-term trend in the unemployment rate. The second relates to the large fall of standard working hours over the same period, again associated with the absence of a trend in the unemployment rate (see Maddison (1991)). In our model neither productivity nor standard hours have any effect on the unemployment rate; some other formulations (for example, Shapiro and Stiglitz (1984)) do not involve these appealing properties.

As far as previous work on work-sharing is concerned our findings are in accordance with it. Starting with Brechling (1965), the theoretical literature has questioned whether government imposed standard hours reductions can be a cure for unemployment (see, for example, Hart (1984), Calmfors (1985), Hoel (1986), Hoel and Vale (1986), Hart (1987), Booth and Sciantarelli (1987), Calmfors and Hoel (1988,1989), Hart and Moutos (1995)). The possibility of non-positive employment effects in these studies hinges to a large extent on the presence of imperfect substitutability between hours and individuals, the existence of quasi-fixed employment costs, and the use of overtime hours in equilibrium. Consider, for example, the case of overtime. If there is a constant overtime premium (as is the case in many countries), the marginal cost of a worker rises with a reduction in standard hours, since a given output requires a higher proportion of premium (paid) hours to produce it. In contrast, the marginal cost of an hour remains constant. Firms have, therefore, an incentive – ceteris paribus – to reduce employment and increase overtime hours. The empirical literature seems to be in broad agreement with the predictions of the theoretical models. After reviewing the empirical literature, Hart (1987, p. 160) concludes: "On the basis of the empirical information so far available, there is little reason to modify the general conclusion gained from the theoretical models. Reductions in standard hours as a means of stimulating employment is a highly risky policy strategy." More recent empirical evidence (for example, Hunt (1999)) confirms Hart's earlier assessment. [4]

Recently, Marimon and Zilibotti (2000), in the context of a general equilibrium search model, have largely corroborated the theoretical pessimism expressed in the previous studies. They find that the qualitative effect of a reduction in working hours on employment is ambiguous. Moreover, their simulations suggest that even when unemployment falls in response to a cut in working hours, the decrease in the unemployment rate is very small (less than a quarter of a percentage point for a reduction of working hours from 40 to 35 per week), and it is accompanied by a large fall in output

[4] It must, however, be mentioned that there are some recent studies which find that reductions in working hours produce positive employment effects (see Brunello (1989)).

(about nine percent). There is no ambiguity concerning the qualitative effect of hours reductions in our model; a reduction in standard hours reduces output, but it has no direct effect on unemployment. This result follows from Summers' specification of efficiency wages; in this formulation, productivity – rather than depending on absolute wages – depends on the *relative* attractiveness of opportunities inside and outside the firm. Since all firms are identical, a change in standard hours does not affect relative opportunities and worker productivity. Accordingly, the equilibrium unemployment rate (which is positive in order to make the within the firm opportunities larger than outside it) is not affected.

Despite these negative results concerning mandated reductions in hours, the widespread use of overtime in both Europe and North America, offers some scope for policy intervention which could encourage rather than legislate work-sharing. To pursue this possibility, we first examine the effects of a revenue-neutral employment subsidy financed by a tax on overtime hours.[5] Our simulations indicate that such a policy can be effective. A rather modest initiative (involving a revenue-neutral tax and subsidy equal to about one-third of one percent of GDP) can lead to a drop in the unemployment rate that is between one-half and one full percentage point. Both output and the capital stock rise as well, and there is no discernable effect on total hours worked and workers' income. Thus, this policy passes the political-economy test that there is no obvious source of resistance to the initiative. The source of this Pareto-improving nature of the results lies in the social inefficiency of equilibrium in efficiency-wage models (see Shapiro and

[5] Such incentives have been instituted in France (the Robien Law) and Belgium (the Global Plan). However, because they are not revenue-neutral and there is a fear that they could generate a great strain on public finances, they have been too small scale to have an impact (see Taddei (1998)).

Stiglitz (1984)). A second policy experiment we look at involves a revenue-neutral subsidy of capital – also financed by a tax on overtime hours. Although this policy is more effective in combating unemployment (a similar tax on overtime can reduce the unemployment rate by up to two percentage points in this case), it has adverse distributional considerations. The incomes of employed workers can drop by as much as eight-tenths of a percentage point. Thus, additional compensation measures would be needed to establish political support for this policy.

The remainder of the paper is organized as follows. In section 2, the structure of the model and the rationale that lies behind the calibrated values for three of the model's key parameters is explained. In section 3, the analytical expressions for various results are derived. Calibration for the remaining parameters is explained, and illustrative quantitative results (with sensitivity tests) are reported in section 4. Concluding remarks are offered in section 5.

2. The Model

We begin by reviewing the Summers model – without the several extensions that follow shortly. Firms maximize profits,

$$F(bN) - wN$$

subject to

$$b = (w - x)^{a}$$

where w, x and N denote the real wage paid to each worker, the worker's alternative option, and the level of employment. F is the production function and b is an index of worker effort. á is a positive fraction, so a higher wage in the current job raises the worker's return relative to her alternative and thereby induces higher productivity. Setting the derivatives of profits with respect to both N and w to zero, we have $bF' = w$ and $\alpha bF' = w - x$. Combining these two relationships yields the wage-setting rule

$$w = x/(1-\alpha).$$

Without the asymmetric information that leads to shirking (that is, with $\alpha = 0$), firms simply set the wage equal to the workers' outside option. With shirking, however, the wage is set above this amount, and with all firms behaving in this fashion, employment is lower when the threat of shirking exists. The resulting unemployment is involuntary since firms do not accept offers from the unemployed to work for less than the profit-maximizing wage.

One appealing feature of Summers' model is that a closed-form solution for the unemployment rate emerges in a straightforward manner. The workers' alternative is a weighted average of the wage offered at other firms (which equals w in full equilibrium) and what is received if the individual cannot find work (which Summers assumes is a fraction f times w). The weights in the average are the employment rate, $(1 - u)$, and the unemployment rate, u, respectively. Hence, the alternative wage is $x = (1-u)w + ufw$, and when this definition is substituted into the wage-setting rule, we have

$$u = \alpha/(1-f).$$

In this simple case, unemployment rises with the propensity to shirk and with the generosity of employment insurance. It is useful to note that a rise in labour productivity (an increase in F') has no effect on unemployment. (Instead, it raises real wages.) This property of the model is consistent with economic history. There was a vast increase in productivity over the twentieth century, with a corresponding increase in wages but with no long-term trend in the unemployment rate. As noted earlier, many other formulations of the efficiency-wage hypothesis do not involve this appealing property.

To address work-sharing issues, we must extend this analysis to allow for a distinction between the number of workers and hours per worker, a variable capital stock, and several taxes and subsidies. We do so in stages, beginning with the employees-hours distinction. In this case, profits are $F(bhN) - whN$, where N is number of workers and h is hours per worker. Worker effort and the alternative income possibilitiy for workers are given by

$$b = (wh - x)^{a} h^{-ea} \quad \text{and}$$

$$x = (1-u)wh + ufwh.$$

Worker effort increases with the excess of existing wage earnings over the outside option (as before). The new influence is that, other things equal, productivity is higher when workers have a shorter work week. (The particular form of this relationship is discussed further below.) In addition to the worker-effort relationship, one additional constraint is involved in the firms' optimization:

$$w = \boldsymbol{d}(h/s)^{f}.$$

This relationship summarizes the country's conventions regarding overtime pay. It indicates that firms must pay a higher average wage the bigger is the excess of its hours per worker, h, over what is defined by policy as "standard" hours, s. In this version of the model, both the worker-effort and overtime-wage constraints are substituted into the definition of profits, and the resulting expression is differentiated with respect to employment and hours. The firm chooses the level of wages indirectly by choosing hours. It is left for the reader to verify that the same reduced form for the unemployment rate emerges.

It is useful at this point to anticipate calibration of extended versions of the model. We will need values for three parameters: á, å and N. A reasonable value for á can be determined once representative values for the average unemployment rate and the "replacement ratio," parameter *f*, are substituted into the unemployment rate reduced form. An illustrative value for N can be had by focusing on the "time and a half" convention in North American overtime. Finally, an illustrative value for å can be defended if we give further consideration to household behaviour. Summers did not provide micro foundations for the work effort function (the *b* relationship). But given our need to consider the effects of both wages and hours on work effort, our desire for symmetry (optimization on the part of both firms and households), and our need to calibrate the model, we provide the following brief consideration of the worker's problem.

In keeping with Summers' simplification that attention be restricted to static optimization in policy-oriented models, and the fact that we rely on the underlying interpretation only to suggest a plausible range for the calibration of two parameters, we assume that households maximize the following utility function:

$$p wh + (1 - p)x - ab^g h^e$$

subject to

$$p = b^b \ .$$

ð is the probability that the individual will not be fired; this probability rises as the individual's work effort, *b*, rises (as stipulated in the constraint). The first two terms in the utility function define the individual's income; she receives *wh* if she keeps this particular job, and she receives *x* if she does not. The final term defines the disutility associated with putting effort into one's job (best interpreted as taking time to prepare for work), and with forgoing more leisure by working longer hours. Since it is reasonable to specify that higher work effort increases the probability of keeping one's job, but at a decreasing rate, â must be less than one. Similarly, since it is appealing for the direct effect of both higher effort and longer hours be that utility decrease at an increasing rate, both (and å must exceed unity.

Household behaviour follows from differentiating the utility function with respect to effort, *b*, and hours, *h*, and equating the results to zero. The partial with respect to efforts yields $b = (\beta / \alpha\gamma)(wh - x)^{\alpha} h^{-\varepsilon\alpha}$, where $\alpha = 1/(\gamma - \beta)$. We see that the effort function given earlier derives support from this simple model of households. The partial with respect to hours yields a standard labour supply function which, when differentiated, becomes $(dh/h) = \eta(dw/w)$, where $\eta = 1/(\varepsilon - 1)$ is the elasticity of labour supply. We use assumed values for this elasticity to calibrate å.

We are now ready to explain the fully extended model which we use for analyzing work-sharing. First, consider the division of the population into various groups. As before, *N* denotes number of workers. *U* is the number that are unemployed due to shirking problems, and *r* is the number of permanently unemployed. (We do not maintain that all unemployment is due to asymmetric information and moral hazard issues.) With a population of one, and with *u* standing for the proportion of the (1 - *r*) part of the population that is unemployed ($u = U/(1 - r)$), we have $N = (1 - u)(1 - r)$.

Next consider government policy. The government budget constraint is

$$G + wfh(U + er)(1 - pt) + CN + i\mu K = \tau(1 + \psi)whN + tY + Q(h - s)N.$$

G is direct spending on goods, w is the wage rate, f is the fraction of wages paid to those who are temporarily unemployed. The permanently unemployed receive welfare, and the transfer payment in this case is fraction e of employment-insurance benefits. t is the personal income tax rate, and p is the proportion of these benefits that are taxable. C is a subsidy paid to firms for employing people. For this policy, the exogenous parameter is c, and the overall subsidy payments are $C = cws$, where s is standard, not actual, hours. (When optimizing, firms do not think of this equation holding at the individual level; that is, when choosing w, firms do not think that the overall subsidy rate depends on their individual wage policy.) K and i denote the capital stock and its rental cost, while μ is the rate at which the government subsidizes the rental of capital. For simplicity, we abstract from adjustment costs for capital. To summarize, the lefthand side of the budget constraint involves four terms: spending on goods, employment-insurance (and welfare) benefits, employment subsidies and capital subsidies.

The righthand side of the budget constraint indicates how these expenditures are financed. In order, the three terms are: payroll tax revenue, income tax revenue, and a tax on overtime hours. τ is the employee payroll tax rate, ψ is the ratio of the employer payroll tax to the employee payroll tax, Y is total output, and $Q = qw$, where q is the overtime hours tax rate. (As with C, firms assume that Q is independent of their own wage policy.) The government allows one policy variable to be determined by the model, so that the budget is always balanced.

Firms maximize profits,

$$Y - whN(1 + \psi\tau) + CN - Q(h - s)N - i(1 - \mu)K$$

subject to

$$Y = (bhN)^q K^l \qquad (1)$$

$$b = \boldsymbol{b}(wh(1-t-\boldsymbol{t})-x)^a h^{-ea} \qquad (2)$$

$$w = \boldsymbol{d}(h/s)^f \qquad (3)$$

where x is the workers' alternative option

$$x = wh(1-t-\boldsymbol{t})(1-u)+ufwh(1-pt)\ .$$

After substituting in the three constraints (and not the x equation), we differentiate with respect to the firm's three choice variables are N, h and K. While only the first-order conditions are presented below, we have checked that, for all parameter sets considered, the second-order conditions are satisfied. The first-order conditions (along with the definition of x which is used after optimization) imply:

$$\boldsymbol{q}Y/whN = \Omega \qquad (4)$$

$$um[(1+\boldsymbol{y}\boldsymbol{t})(1+\boldsymbol{f})+q-\Omega(1-\boldsymbol{e}\boldsymbol{a})] = \boldsymbol{a}\Omega(1+\boldsymbol{f})(1-t-\boldsymbol{t}) \qquad (5)$$

$$\boldsymbol{l}Y/K = i(1-m) \qquad (6)$$

where

$$\Omega = 1+\boldsymbol{y}\boldsymbol{t}-cz+q(1-z)$$

$$z = s/h$$

$$m = 1-t-\boldsymbol{t}-f(1-pt)\ .$$

Equation (5) follows from combining the first-order conditions involving N and h with the definitions of u and N.

Defining $g = G/Y$, and using (4) and (6), the government budget constraint can be re-expressed as

$$(1-u)(1-r)[t(1+y)+q(1-z)-cz-(\Omega/q)(g-t-(ml\ /(1-m))]$$

$$= f(1-\ pt)(u(1-r)+er) \qquad (7)$$

<u>3. Policy Effects</u>

We take the total differential of the equations numbered (1) through (7), along with the definitions of z, N and x, to solve for the changes in Y, N, K, x, u, h, w, b, z and one policy variable that follow from four different exogenous events. The four events are:

<u>Policy 1</u> - a change in the generosity of employment insurance financed by the necessary adjustment in payroll taxes (a change in f with ô endogenous),

<u>Policy 2</u> - a work-sharing initiative – a reduction in the official designation for standard hours with the budgetary implications accommodated by a change in payroll taxes (a reduction in s with τ endogenous),

<u>Policy 3</u> - the introduction of an employment subsidy financed by a tax on overtime hours (an increase in c with q endogenous),

<u>Policy 4</u> - the introduction of a subsidy that reduces the rental cost of capital - financed by a tax on overtime hours (an increase in ì with q endogenous).

The second and third experiments represent the focus of this work. The first experiment is included as a mechanism to ensure that the calibration of the model is credible. There is widespread consensus concerning the quantitative implications for unemployment that follow changes in the generosity of employment insurance, and we want this model's predictions to be consistent with this concensus.[6] The fourth experiment is included so that capital and employment subsidies can be compared. All policy variables except the one that is adjusting to maintain a balanced budget are exogenous. Also, given perfect capital mobility, the interest rate is exogenous.

After setting the *initial* values of c, q, and ì equal to zero, and eliminating the changes in the other endogenous variables, we focus on a set of five equations that determine changes in u, h, w, K and the residual policy variable (τ as the system is written below). We denote absolute changes by d and percentage changes by Δ. Cramer's rule is then used to derive policy multipliers. The manipulations that are involved to reduce the system to this more compact form are now explained.

The total differential of (3) yields

$$\Delta w = f(\Delta h - \Delta s).$$

This equation represents the first line in the matrix below. The total differential of (4) implies:

$$\Delta Y = \Delta N + \Delta h + \Delta w + \Delta\Omega .$$

When this equation is combined with the differential of (1), we have

$$(1-q)(\Delta N + \Delta h) + \Delta w + \Delta\Omega = q\Delta b + l\Delta K. \tag{8}$$

Substituting the definition of x into equation (2), we can re-express the relationship as $b = b(um/v)^a\, h^{-ea}$ where $v = (1-t-t)(1-u) + uf(1-pt)$. Then, using the differentials

[6] Atkinson (1999) has raised valid concerns regarding the proper theoretical modeling of actual employment insurance systems. Nevertheless, our orthodox modeling produces an answer consistent with the econometric estimates of the effects of changes in unemployment benefits on the unemployment rate

of the definitions of N, z, m, v, Ù, and this version of the definition of b, equation (8) can be consolidated, and the result is the second line in the matrix below. The third, fouth and fifth rows in the matrix come from the differentials of equations (5), (7) and (6) respectively.

$$A[du \quad \Delta h \quad \Delta w \quad d\tau \quad \Delta K]' = B[\Delta s \quad df \quad dc \quad dq \quad dt \quad dg \quad dm]'$$

The A and B matrices (respectively) are:

$$\begin{bmatrix} 0 & -f & 1 & 0 & 0 \\ C_{10} & -(1-q) & -1 & C_{11} & l \\ B_1 & -B_3 & 0 & -B_5 & 0 \\ -C_4 & 0 & 0 & C_5 & 0 \\ -1/(1-u) & 1 & 1 & y/(1+y\tau) & -1 \end{bmatrix}$$

$$\begin{bmatrix} -f & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & aqA_3 & -z/(1+y\tau) & (1-z)/(1+y\tau) & -aqA_2 & 0 & 0 \\ -B_3 & B_2 & -B_6 & B_7 & B_4 & 0 & 0 \\ 0 & C_8 & C_6 & C_9 & -C_7 & C_1C_3/q & C_{12} \\ 0 & 0 & z/(1+y\tau) & -(1-z)/(1+y\tau) & 0 & 0 & -1 \end{bmatrix}$$

The summary coefficients are:

$$A_1 = (1/u) + (m/v)$$

$$A_2 = ((1-u+ufp)/v) - ((1-pf)/m)$$

$$A_3 = (u(1-pt)/v) + ((1-pt)/m)$$

$$A_4 = (1-u)/v) - (1/m)$$

$$A_5 = (1+y\tau)(f+ea)$$

$$B_1 = mA_5$$

$$B_2 = u(1-pt)A_5$$

(see the relevant discussion in Section 4).

$$B_3 = 0$$

$$B_4 = u(1-pt)A_5 - a(1+f)(1+yt)$$

$$B_5 = uA_5 + a(1+f)[y(1-t-t) - (1+yt)] - umy(f+ea)$$

$$B_6 = z[um(1-ea) + a(1-t-t)(1+f)]$$

$$B_7 = (1-z)a(1-t-t)(1+f) - um(1-(1-z)(1-ea))]$$

$$C_1 = \Omega$$

$$C_2 = (1+y)t - (g-t)C_1/q$$

$$C_3 = (1-u)(1-r)$$

$$C_4 = (1-r)[C_2 + f(1-pt)]$$

$$C_5 = C_3[1+y(1-((g-t)/q))]$$

$$C_6 = zC_3[1-((g-t)/q)]$$

$$C_7 = (C_1C_3/q) + fp(u(1-r)+er)$$

$$C_8 = (1-pt)(u(1-r)+er)$$

$$C_9 = C_3(1-z)[((g-t)/q)-1]$$

$$C_{10} = aqA_1 + ((1-q)/(1-u))$$

$$C_{11} = aqA_4 - (y/(1+yt))$$

$$C_{12} = (C_3 l\Omega)$$

The only qualitative results follow from the system's recursivity: the third and fourth rows are sufficient to solve for the responses of the unemployment rate and the residual policy variable. Indeed, when government spending, not the payroll tax, is the residual policy instrument, the unemployment-rate response follows from the third row alone. In any event, because of this recursivity, one central result on work-sharing emerges without any appeal to calibrated values: the unemployment rate is *unaffected* by legislated changes in standard hours. According to this analysis, then, the "European" approach to work-sharing cannot be expected to change the unemployment rate. Of course, this initiative still affects wages, hours and investment, and we want to compare this mandated approach to one which works more directly through market incentives. Thus, we proceed with the calibrated version of the model.

4. Calibration and Quantitative Results

As just noted, since the multiplier expressions are fairly messy, we evaluate them numerically with a calibrated version of the model. For the base case, we consider the following parameter values:

θ	labour's share of output	0.66
ë	capital's share of output	0.30
r	proportion of population permanently unemployed and on welfare	0.03
u	proportion of remaining population unemployed	0.04
f	unemployment benefits as a proportion of wage	0.30
t	employee payroll tax rate	.015
ψ	employer payroll tax as a proportion of τ	1.40
t	personal income tax rate	0.15
p	taxable proportion of unemployment benefits	0.80
e	welfare as a proportion of unemployment benefits	0.50
c	initial value of the employee subsidy	0.00
q	initial value of the tax on overtime hours	0.00
ì	initial value of the subsidy on capital	0.00
z	initial ratio of standard to total hours	0.96
å	Direct effect of hours on utility	3.00
N	wage adjustment parameter	0.40

The first four parameters should not be controversial; they pin down the initial unemployment rate (6.9 percent) and the shares of income going to labour and capital.

The income shares sum to less than one, since slight decreasing returns to scale is required for the second order conditions to be satisfied. The next three parameters define the employment insurance system. For this baseline simulation, the parameter values are intended to reflect Canadian institutional arrangements. (The rationale for focusing initially on the Canadian case is explained more fully below.) The actual wage-replacement ratio, f, is higher than the value reported here, but there is a qualifying period, a maximum length of time for receiving benefits, and a cap on benefits during the collection period. Since we have followed Summers and modeled an employment-insurance system without such limits, we have had to reduce the replacement ratio and the payroll tax rates accordingly (as OECD analysts do when making international comparisons). The ratio of the employer and employee contribution rates is as in the Canadian system. The next six parameters define the remaining features of the tax and transfer system. These values, and the government budget constraint, imply a program spending to *GDP* ratio of 13 percent - consistent with the actual policy of the Canadian federal government. The reduced form for the unemployment rate is used to pin down parameter á; for these values, á = 0.0083.

We now discuss the rationale behind the calibration for the last three parameters. The typical experience for OECD countries is that average hours are higher in peak business-cycle years (compared to recession years) by about 4 percent (see, Hart (1987)). In the baseline calibration, then, we assume that standard hours (36 hours per week) represent 96 percent of average hours (h = 37.5 hours), and $z = s/h$ = 0.96. We obtain a value for the wage-adjustment parameter, N, by the following reasoning. When h rises from 36 to 37.5, the percentage increase in h/s is 4.2. The overall wage is a weighted average of the base rate, call it ù, and the overtime rate which, at time and a half, equals (1.5)ù. When h = s = 36, the average wage is ù; when h = 37.5 and s = 36, the average wage is (36/37.5)ù + (1.5/37.5)(1.5)ù. The percentage rise in wages that accompanies the increase in hours is 2. Since parameter N is the ratio of these two percentage changes, this illustration suggests that a value for N in the 0.48 range is appropriate. We take 0.4 as the baseline value and, since we have not provided structural underpinnings for this wage-adjustment function – beyond its consistency with the time-and-a-half convention – we consider extensive sensitivity tests (values of N between 0.2 and 0.6). Finally, in section 2 above, we reasoned that the remaining parameter can be calibrated if an assumption concerning the wage elasticity of labour supply, ç, is made. Since we found that $e = (1 + h)/h$, and since we consider the following values for ç: 0.25, 0.50 and infinity, parameter å ranges between 5.0, 3.0 and 1.0. For the baseline case, we take å = 3.0.

One final consideration is important if we are to defend the calibration as credible. We must ask the model to answer a question for which we already "know the answer." With this in mind, we note that over the past 40 years, the generosity of the Canadian employment-insurance system was approximately doubled during the first two decades and then returned to its original level over the second two. Corak (1996) has summarized the extensive empirical work, and he concludes that there is a consensus in the literature – that increased generosity of this magnitude pushed the unemployment rate up by something between six-tenths and one full percentage point. If our model is realistic, then, cutting the system's generosity in half (setting df = -0.15 from the initial value of f = 0.3) should increase the unemployment rate by about this much. Since we find that the unemployment rate increases by nine-tenths of one percentage point, we conclude that the model is reliable and that the following numerical calculations can be regarded as representative and instructive.

Work-Sharing: We model the mandated approach to work-sharing as a legislated reduction in standard hours; in particular, we set ds = -2/36. We already know, on analytical grounds, that the model does not support this initiative as a mechanism for lowering unemployment. But what are the other effects? These are reported in Table 1; parameter set 5 is the baseline case. Wage rates rise by one-third of one percentage point, but since average hours drop by 4.7 percent, the total wages received by those already employed are reduced. Further, the quantity of capital employed drops by 4.4 percent.

The following intuitive reasoning may help readers interpret these results. Initially, the government legislation forces firms to label fewer of their total hours as "standard." Given the time-and-a-half wage relationship, firms face the prospect of a higher wage bill and lower profits, if they cannot push this cost over to workers, or cut other costs. Firms have three ways of reducing costs. First, they can lower hours-per-worker, thereby lowering the proportion of hours that are "overtime," and therefore the average wage rate. But firms do not want to react "too much" in this fashion, since worker productivity is reduced as well. The second option firms have is to reduce the number of individuals employed, and the third is to hire less capital. The results indicate that the hours and capital responses are utilized to a noticeable degree. The mandated approach to work-sharing involves costs (lower wage receipts for those with jobs and lower investment) without the intended benefit (lower unemployment).

An Employment Subsidy Financed by a Tax on Overtime Hours: The alternative approach to work-sharing rejects the imposition of quantity constraints. Instead, taxes and subsidies are used, in a revenue-neutral way, to make it in the firms' self interest to hire more people. As an illustration, we consider $dc = 0.006$. This initiative represents an employment subsidy whose total value is roughly six-tenths of one percent of total labour income. This, in turn, represents about one-third of one percent of *GDP*. Compared to other major policies undertaken by western governments, we regard this magnitude of initiative as illustrative from a practical policy perspective. As is evident in Table 2, this initiative is more effective; in the baseline case (parameter set 5), it results in a permanent reduction in the unemployment rate of seven-tenths of one percentage point. Further, this favourable effect does not involve trade-offs. There is no discernable change in either overall hours or wages, so individuals who are already employed are not hurt. Also, there is an increase in the quantity of capital employed (an increase of one-half of one percentage point), so this initiative does not represent a disincentive to invest. In short, the analysis supports this policy. The carrot-and-stick method of inducing job sharing appears to work much better than does the simple passing of a law that is intended to generate more job sharing.

A Capital Subsidy Financed by a Tax on Overtime Hours: Since governments have a long history of subsidizing capital – not labour – it is instructive to explore this alternative use of the revenue raised by a tax on overtime.[7] For this illustration, we set dì = 0.02, since this represents a similar initiative – in the sense that the revenue

[7] Fuest and Huber (1998) present evidence showing that subsidies to investment are empirically much more important than employment subsidies in OECD countries.

implications are about one-third of one percent of *GDP*, as before. As reported in Table 3, this policy causes unemployment to fall more dramatically – by 1.3 percentage points in the baseline case. And the favourable effect on investment is much bigger as well – capital rises by three and one-third percent. But the costs – in terms of diminished political support are bigger as well. Average hours fall by six-tenths of one percentage point, and the average wage rate falls by one-quarter of one percentage point. So those already working do take a hit in this case. The resulting increase in shirking lowers productivity by more than the increased availability of capital raises productivity. It appears that implementation may need to be accompanied by additional measures that are designed to compensate those who lose.

According to the baseline simulations, then, the employment subsidy is the policy that receives the most support from the analysis. This revenue-neutral initiative brings a significant reduction in involuntary unemployment, along with no decrease in capital investment and the wages of those already employed. According to the model, it is difficult to see why political resistance to this policy would emerge. Tables 1, 2 and 3 contain results for other parameter sets. Outcomes are quite insensitive to variations in most of the parameters, so only some alternatives for parameters N and å are reported in the tables. Even these sensitivity tests indicate little variation in results. It is left for the reader to use the tables to verify that the conclusions based on the baseline case are robust.

5. Conclusions

This paper is motivated by the fact that there is little communication between two important groups. On the one hand, a subset of policy-makers and policy advisors are passionately committed to work-sharing. Often this group calls for a mandated approach. On the other hand, many mainstream economists are highly skeptical of work-sharing, and it is difficult to find *any* theoretical analyses which are supportive of this proposal. This paper has tried to fill this gap; it has analyzed work-sharing in an optimization-based macro framework, and the model has been calibrated for direct policy application.

Work-sharing can be pursued in two ways – by using legislation to make the goal of the policy override the self interest of individual market participants, and by using incentives to make the goal of the policy and the self interest of market participants coincide. The paper has shown that the second approach brings preferred results, and that analysts should not reject work-sharing just because they may be skeptical of the mandated reduction in hours approach. This is an important consideration, since many are concerned that the mandated approach interferes with existing collective bargaining arrangements.

It must be admitted, of course, that our model is highly aggregative and simplified. Several extensions would be valuable. For one thing, as the reference to collective bargaining suggests, the model can be extended to allow for the interaction between firms and unions. Also, in future work, we plan to consider skilled and unskilled workers separately. In that context, the carrot-and-stick approach to work-sharing could be similar to the low-wage employment subsidy advocated by Phelps (1997) and Solow (1998). Our analysis will extend their work by considering employment and hours separately, and by being explicit about how the subsidies are financed, and how they affect investment and the wages of others. Also, our analysis will be able to address an issue raised by Bauer and Zimmerman (1999). They have argued that, since most overtime work is done by skilled workers, a reduction in overtime forces firms to hire fewer skilled workers. If both groups of workers are complementary inputs, fewer unskilled will be hired as well. An extended version of our model will allow this consideration to be one of several that can be assessed together in a simple but general equilibrium setting. In addition to providing the results reported here, the baseline model has paved the way for this future work.

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Table 1. Effects of a Reduction in Standard Hours

Parameter Set	Change in Unemploy-ment Rate	Percentage Change in Hours	Percentage Change in Wages	Percentage Change in Capital
1. å = 1; N = .2	0	-4.1	0.3	-3.8
2. å = 1; N = .4	0	-4.7	0.3	-4.4
3. å = 1; N = .6	0	-5.0	0.4	-4.6
4. å = 3; N = .2	0	-4.1	0.3	-3.8
5. å = 3; N = .4	0	-4.7	0.3	-4.4
6. å = 3; N = .6	0	-5.0	0.4	-4.6
7. å = 5; N = .2	0	-4.1	0.3	-3.8
8. å = 5; N = .4	0	-4.7	0.3	-4.4
9. å = 5; N = .6	0	-5.0	0.4	-4.6

Table 2. Effects of an Employment Subsidy

Parameter Set	Change in Unemploy-ment Rate	Percentage Change in Hours	Percentage Change in Wages	Percentage Change in Capital
1. å = 1; N = .2	-1.1	0*	0*	1.3
2. å = 1; N = .4	-0.7	0*	0*	0.6
3. å = 1; N = .6	-0.5	0*	0*	0.4
4. å = 3; N = .2	-1.0	0*	0*	1.2
5. å = 3; N = .4	-0.7	0*	0*	0.6
6. å = 3; N = .6	-0.5	0*	0*	0.3
7. å = 5; N = .2	-1.0	0*	0*	1.2
8. å = 5; N = .4	-0.7	0*	0*	0.5
9. å = 5; N = .6	-0.5	0*	0*	0.3

*Rounded to zero if the response is smaller than 0.001 percent.

Table 3. Effects of a Capital Subsidy

Parameter Set	Change in Unemploy-ment Rate	Percentage Change in Hours	Percentage Change in Wages	Percentage Change in Capital
1. å = 1; N = .2	-2.1	-0.3	-0.1	4.3
2. å = 1; N = .4	-1.4	-0.6	-0.2	3.4
3. å = 1; N = .6	-1.0	-0.5	-0.3	3.1
4. å = 3; N = .2	-2.0	-0.4	-0.1	4.2
5. å = 3; N = .4	-1.3	-0.6	-0.2	3.3
6. å = 3; N = .6	-1.0	-0.5	-0.3	3.1
7. å = 5; N = .2	-2.0	-0.4	-0.1	4.1
8. å = 5; N = .4	-1.3	-0.6	-0.2	3.3
9. å = 5; N = .6	-1.0	-0.5	-0.3	3.1